Implementation of the <u>C</u>ollision <u>R</u>ecords <u>A</u>nalysis and <u>S</u>afety <u>H</u>azard <u>E</u>valuation <u>S</u>ystem (CRASHES)

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ABSTRACT

The City of Calgary Transportation Department embarked on a process of developing protocols for the implementation of a collision records system primarily for two reasons. First, there was a business need to replace the current system due to the pending decommissioning of the mainframe application, and secondly the opportunity to expand technically, beyond a record repository and develop a consistent, comprehensive, technically robust application that would allow for proactive management and analysis. In this way the city of Calgary could continue to implement procedures needed to improve safety and to ensure viability and integration between the land use planning, transportation, and operations processes.

BACKGROUND

In 1992, The City of Calgary began a Traffic Accident Analysis System (TAAS) software initiative involving three business units: Traffic Operations (now called Traffic Engineering), the Calgary Police Service, and the Provincial Attorney General. That project, under the sponsorship of the City of Calgary, Traffic Operations Division, resulted in a mainframe-based in-house developed Natural / Adabas system (see the original specifications in “Traffic Accident Analysis System (TAAS): - Stage I Report”, “ - Stage II Report”, “ - Stage III Report”) (1). The mainframe application interfaced with the Calgary Police Service’s traffic accident reporting module on the Police Information Management System (PIMS), and the City’s Road Network (RoadNet), that includes intersection and addressing data.

Deloitte and Touche Consulting conducted a Strategic Information Systems Review in 1998, in which it was identified that The City of Calgary supported a very complex, heterogeneous data processing environment (2). To reduce the costs associated with this situation The City decided to move towards a simplified and standardized technical infrastructure. This involved eliminating the Multiple Virtual Storage (MVS) mainframe including software, hardware and resources. The Decommissioning and Migration (DaM) project was created to manage the corporate-wide decommissioning and migration of MVS mainframe applications towards a distributed computing environment.

In 2001, with the decommissioning of the mainframe originally scheduled for December 31, 2001 (see “DaM Strategy Report”), a Traffic Accident Analysis System Study was initiated (3). This was to be a high level analysis in preparation for development of an Enhanced Collision Analysis and Record System (CARS) deployment (see “Traffic Collision Scope of Work”) (4).

CRASHES (**C**ollision **R**ecords **A**nalysis & **S**afety **H**azard **E**valuation **S**ystem) evolved from the CARS project and how the associated application is now referred. The acronym replaced the mainframe “accident analysis” application (TAAS) and the initial replacement (CARS). The acronyms (CARS and TAAS) were rejected due to the fact there were different applications of the same name resident at the City of Calgary, and this created confusion when dealing with application maintenance. Further, the moniker CRASHES directly relates to the activity of collision analysis. At various stages of the evolutionary process the application had several monikers, and associations with related products.

- CARS (Enhanced Collision Analysis & Record System)
- Traffic Accident (Mainframe application full name)
- TRASACC (Mainframe application acronym)
- TAAS (Mainframe application acronym)

An analysis was carried out to determine the best approach to replacing the mainframe Traffic Accident application while providing Traffic Engineering with enhanced functionality (refer to "Traffic Collision Feasibility Study" and "Traffic Collision Solution Strategy") (5 &6). The purpose was to determine if there was potential for the selection of a packaged software solution purchase versus an in-house build option.

Research into potential packaged products was completed and a Request For Information (RFI) was issued to gather further information (7). The responses and the products were evaluated by a cross section of people within The City. The selection committee consisted of representatives from the Traffic Engineering Division (user functionality); Information Technology to ensure consistency with architecture, and sustainment requirements, and Finance; two products emerged as best fit. Through follow up conversations one was selected and recommended. Budget constraints put the project on hold until 2002.

With the new fiscal year and a new budget allotment the project was renewed. Draft Contract negotiations were completed in December of 2002 with the selected vendor. Beginning 2003 February, phase I of the project was started implementing the chosen solution this included the signing of the legal documentation and an annual maintenance agreement. Proceeding concurrently with the implementation (Phase I) of the CRASHES project was the directly related project: the Decommissioning and Migration (Dam) initiative (6). Indirectly, two other projects affected implementation: the Traffic Count system (TrafCount) and the ESRI ArcGIS Geographic Information System.

The TrafCount system is related in that it supplies traffic volume data to the CRASHES application for the purposes of generating collision rates. While the Vendor has a traffic count product that can be integrated directly to this application, it was not selected due to the recent development of an in-house traffic count system. Further, at the time of implementation, the vendor traffic count application was viewed as an immature product in relation to the in-house application. It had some features that were advantageous but others viewed as requiring enhancement to meet the existing traffic count application functionality.

The ESRI data layers are used to feed data to the system for enhancement to the analytical functionality of the program (RoadNet, Signals, Intersections, Red-Light Camera, Truck Routes, Speed, Land Use, Volumes, and Common Names), and also for the purposes of collision location referencing.

PROJECT PLAN

CARS (Collision Analysis & Reporting System) RFI

The City of Calgary provides services to more than 960,000 people living within the municipal jurisdiction of the City. Calgary is one of the fastest growing cities in Canada and has to plan for continuous expected growth in population and the subsequent demand for services.

The City of Calgary collision system continues to receive a regular batch data transfer from the Calgary Police Service (and potentially, additional data from other sources as well). The application needed to store, analyze and display transportation collision (accident) data in report and Geographical Information System (GIS) formats. The main business objectives are:

- To support the analysis of high collision locations, and
- To provide background information to assist in the planning of new, or enhancements to, the City transportation infrastructure

To provide a feel for the size of the system, information on the anticipated User base and data volumes have been included. The anticipated user base will consist of:

- 2 Administration Users
- 4 Power Users
- 72 additional users (maximum, 36 concurrent - estimated)

The current data volumes are:

- Reception of approximately 650 collision records per week,
- Maintenance of 5 years worth of data on-line

Additional information regarding the implementation timing and approach: Should the City of Calgary decide to proceed with the Collision Analysis & Record System, implementation was anticipated for the first quarter of 2002. The Collision Analysis and Record System would be phased into production throughout 2002.

The Decommissioning and Migration (DaM) Initiative

The DaM (Decommissioning and Migration) Phase IV Project Framework defined the implementation phase of the mainframe computer decommissioning and migration initiative. This included a complete project definition as well as a detailed project plan. The plan was comprised of schedule, risk management, organization and budget components.

The framework identified the magnitude of the DaM initiative in terms of cost, duration and required resources. This information provided the basis for managing the expectations of the Project Sponsor, Project Manager, in this case the Transportation Department, and other project stakeholders.

During the course of the Strategic Information Systems Review conducted by Deloitte and Touche during the second and third quarter of 1998, it was identified that The City of Calgary supported a very complex, heterogeneous data processing environment. This included an excessive number of different hardware and software products with support costs increasing proportionately as new technologies were added.

In order to reduce the costs associated with this situation The City decided to move towards a simplified and standardized technical infrastructure. This involved eliminating the MVS mainframe including software, hardware and resources. The DaM project was created to manage the corporate-wide decommissioning and migration of MVS mainframe applications towards a distributed computing environment.

The DaM initiative was organized into four phases:

- Phase I – DaM Inventory of Applications
  - An inventory of mainframe applications was developed for the specific purpose of decommissioning and migrating MVS applications. This was used to identify the number and types of applications that needed to be addressed within the project.
- Phase II – DaM Application Evaluation
  - All mainframe applications identified in Phase I were evaluated to determine how they could best be replaced in a distributed environment. In addition, estimates in terms of cost and time were compiled for each relevant application.
- Phase III – DaM Implementation Planning
  - Based on the information gathered in the first 2 phases, a project plan was developed to scope out the DaM implementation effort. The key deliverable components included budget, schedule and approach, and were presented within this framework document.
- Phase IV – DaM Implementation
  - The last phase of the DaM initiative focused on the physical replacement of the mainframe applications. It was carried out as described in the body of this DaM framework document, and the implementation of the CRASHES application was the result of Phase IV implementation.

TAAS (Traffic Accident Analysis System) Decommissioning Strategy

The Traffic Accident Analysis System consisted of an in-house mainframe application that interfaced with the City's Road Network, including intersection data, Addressing data, and Calgary Police Service Traffic Accident Reports. The system originally was to be decommissioned by the end of 2002, when the City's mainframe computer was retired from service. Due to technical reasons, and other applications, the mainframe MVS remains active.

PROJECT/FUNCTIONAL REQUIREMENTS
CRASHES (Collision Records Analysis & Safety Hazard Evaluation System)

Vendors were requested to provide as much detail as required to show how their systems would meet the following City of Calgary standards and requirements (7). The responses to the following criteria formed the basis for evaluation by the selection committee. This resulted in a short list of Vendors who were subsequently asked to either respond to a Request for Proposal or enter into negotiations. A disclaimer noted that if, as a result of the evaluation, the selection committee determined that there were no suitable products available, the RFI process would be canceled and other options would be considered.

High-Level Requirements

Technical Infrastructure:

- Operating System:
    - o Data Base Server Operating System: Unix Solaris 2.8 or Windows NT 4.0;
    - o Application Server Operating System: Unix Solaris 2.8 or Windows NT 4.0;
- Desktop Client Operating System: Windows NT WKST 4.0;
- Enterprise Data Base Management System: Oracle V8.x;
- Enterprise Geographic Information System (based on ESRI technology): ArcView 3.2 and extensions (migrating to ArcGIS 8.1): Network Analyst; Spatial Analyst; 3D Analyst; Crystal Reports; ArcInfo 8.1 Workstation; MapObjects 2.0a (preparing to upgrade to MapObjects 2.1); ArcIMS 3.1; SDE 3.0.2.2 on Oracle (migrating to ArcSDE 8.1) database; The development environment for GIS uses Avenue, Visual Basic and MapObjects;
- Network Architecture: TCP/IP.

Security

- As a business requirement, the application administrator of this system would not require administrative privilege at the Operating System level or database level. If this was required, please explain why.
    - o Please describe the security mechanisms available within the application
        - ▪ How are roles assigned to specific groups;
        - ▪ How can access be structured at the row or column level;
        - ▪ How does the client authenticate themselves within the system:
            - Is the system authentication tied to the NT user ID and Password;
            - Does the application support strong authentication mechanisms;
        - ▪ How is data encryption supported?

Manageability

- Indicate how often new releases (major and minor) of the product are typically offered and provide a product release summary for the last two years.
- Provide the product direction strategy for migration to ESRI's ArcGIS 8.x platform and the support for the ArcSDE 8.x geodatabase.

Business Functionality

- Indicate if, and <u>briefly</u> describe how, the software provides functionality under the following business components:
    - o Collision Data Feeds (include import data formats) – batch, on-line, mobile (phone, wireless)
    - o Collision Record Validation;
    - o Collision Record Analysis – built in analytical functions (e.g., collision rates, descriptive statistics), customizable;
    - o GIS integration - display, analysis, integration with collision diagramming, integration with other data sources;
    - o Collision Representation (Location Mapping, Collision Diagramming, Collision Scene Sketches - provide example collision diagrams / maps) –

map collisions to locations, map collisions to an intersection / mid-block by type, import collision scene pictures;
    - Account Administration;
    - Reporting – canned, ad-hoc, how new reports are added; and
    - Data import / export capability

Application Cost

- Cost information for the application as described by the following cost components:
    - One-time license costs:
        - Include all required modules;
        - Include discounts for quantities and / or site licenses;
    - Annual software maintenance costs for the four years following system implementation - indicate what the percentage to the original license costs this is;
    - New version releases of the software – indicate if included in the software maintenance costs or if they represent an additional cost;
    - Any other costs associated with the implementation, i.e., testing support, installation, consulting, application interface development, training, etc.

Upon completion of the RFI process, two vendor applications appeared to meet the functional and high-level requirements. Further discussions were held with the identified vendors for product clarification purposes. These discussions led to contract negotiations with one of the identified vendors; Trimap Communications and their web-based (or client-server) OnTrac software. Contracts were finalized and a project plan was subsequently developed.

CRASHES IMPLEMENTATION

The scope of the CRASHES project included the implementation and configuration of the OnTrac2 application by Trimap Communications Inc. with associated interfaces and training. In general the project was divided into several phases. The subsequent phases were clarified in greater detail as the project proceeded.

Phase 1 was broken down into two sub-sets to aid in implementation but this was based on an aggressive time-line with the assumption of simplified processes. Due to constraints and issues that arose, the two sub-sets have become one.

Phase 1: Base Deliverables

- Phase1, sub-set 1 is the implementation of the basic application, OnTrac2, with the historical data converted and the feed from Calgary Police being incorporated into the system
- Phase 1, sub-set 2 is the addition of the new data elements (which were dependant on Police approval and availability of Police resources) not in the current dataset and the inclusion of additional analytical capability.

Phase 2: Enhanced Deliverables

The Phase 2 component that related to the original contract award consisted of the addition of more detailed analysis capability. Considered in-scope were:

- Implementation of the OnTrac2 application Phase 1 Base deliverables:
- Hardware identification, purchase and implementation, as required to meet current Vendor certification requirements
- Decommissioning of the Mainframe application and associated interfaces that are not used by other applications
- Implementation of Ontrac2 software with Base Deliverables (as written in the contract, Schedule A, December 23, 2002):
- Import and parsing of collision data provided by The City of Calgary police Services. (Note: If standard data elements were expected to be collected in the future (e.g., age and sex information) these elements were to be defined at this time.
- Validate collision records based on user-configurable data validation rules and hard-coded rules specific to The City of Calgary.
- Manage the collision data import and validation process.
- Search collision records based on data contained in the collision record and / or data contained in the map reference tables.
- Display of summary collision records data based on search criteria.
- Access collision details for a specific collision by selecting that collision from a listing of records generated by a specific search.
- Change collision details for a specific collision by selecting that collision from a listing of records generated by a specific search.
- View the location of a specific collision by selecting that collision from a summary of records generated by a specific search.
- Change location-related details for a specific collision by selecting that collision from a summary of records generated by a specific search and then using the map display screen.
- Assign location-related details for a specific collision that has not been spatially referenced by selecting that collision from a listing of records generated by a specific search and then using the map display screen.
- Create a text-based summary report for a specific collision (codes are replaced by text descriptions).
- View locations of all collisions contained in the summary of records generated by a specific search (using the map display screen).
- Create standard reports describing all collision records generated by a specific search.
- Select specific frequency or rate reports and summarize, by location, all records generated by a specific search.
- Export standard summary reports to Microsoft Excel for further analysis.
- Select collisions based on map-based identification of intersections and mid-block locations.
- Display collision details by selecting a collision referenced on the map display screen.
- Import existing base mapping data based on a prescribed standard format (includes base road network, cosmetic objects, intersections, and monument and address data).
- Report on map and data inconsistencies.
- Single user type and privileges.
- Loading a version of RoadNet data into the application tables to form the base for mapping of collisions

- Coordinating City standard means for Vendor remote Maintenance

Figure 1 identifies the tasks associated with the implementation of the CRASHES application, and assigns responsibility for the task completion. Functional requirements that were not in scope during the first two phases of the project, however were implemented in a subsequent phase include:

- The implementation of the OnTrac2 application Phase 2 Enhanced Deliverables:
  - Provision of the OnTrac2 standard annual reporting Module
    - Run-time Microsoft application connected to the OnTrac2 database resident in Oracle
    - Generation of a standard publication quality OnTrac2 annual report (including a publication quality pdf document) based on new data structure (The French version was not included)
    - Limited modifications to the existing report to meet City of Calgary requirements (These modifications were limited to excluding specific components of the existing report where The City of Calgary has not collected sufficient data and to minor modifications such as the incorporation of the applicable City of Calgary logo.)
  - Functionality enhancements to the OnTrac2 main module
    - Revisions of symbology used to meet City of Calgary standards
    - Advanced intersection conflict analysis
    - Revisions to standard OnTrac reports
    - Functionality to synchronize distance offset and XY coordinate data
    - Multiple User types (3) having specific privileges
    - Standard thematic mapping of search results
    - Safety Performance Functions (SPF's) based on the "Rate Quality Control" approach
- Any significant business process re-design or organizational review / design
- Automated interface with Traffic Count for volumes
- ArcView representation of the data
- Hardware configuration changes to meet new Architectural City directions
- Funding Applications

Critical Success Factors

Factors the Stakeholders deem are critical to the success of the project:

- Legal Documents completed and signed off
  - Confidentiality Agreement
  - Contract
  - "Remote Vendor Access Agreement" (identified as the same as the Confidentiality Agreement")
  - Vendor resources security cleared
- Implementation of the vendor package, on time and on budget, with Traffic Assessment staff trained and ready to use it
- SVG Viewer 3.0, software required to graphically view collision data, certified by R&D and installed on the applicable desk-side machines
- Committed LUM Executive Management to sponsor and promote project objectives
- Committed Project Team that works together to achieve the project and Team objectives

- Committed City Technology groups that work together to achieve project objectives during a time of Process re-modeling
- Vendor, Business and ITS personnel commitment and availability
- Well-defined project Framework and Project plan
- Effective scope management
- Business representation, participation and availability
- Effective communications to project stakeholders
- Availability of resources
- Standard processes

Constraints

The constraints that may impact how the project will be conducted may include budget, staff availability, deadlines, lack of technology, and lack of available technical or business knowledge.

- Availability of ROADS business and technical resources
- Availability of ITS resources due to commitments to other IT projects and sustaining existing applications and to vacation schedules
- Availability of Vendor resources
- Budgets / Funding
- Current status of required project documentation
- Clear and documented internal processes
- City Technology groups working in a state of Process re-modeling and resource redeployment
- Technology acceptance / flexibility in handling City / Vendor (application) constraints
- City restructuring of Business Units and associated responsibilities

Project Approach

The following sequence of events formed the basis for the project work plan, and separate documentation was crafted for each major element of the work plan (8). Figure 2 outlines the implementation and phasing of each of the components.

- Application Strategy:
    - The packaged application as recommended in previous project phases.
    - Due to implementation delays; the recommendation was carried forward and no changes were made with respect to the identified package.
    - The original Client Server solution was replaced with a web-based (intranet) solution using Java, XML, and Oracle as the back-end database.
    - As collision analysis and records management are niche markets and each municipality is different, customization within the framework of the application was be required
- Project Phases:
    - An aggressive time schedule was negotiated with the vendor during initial negotiations
    - Phase 1: Sub-set 1: Base Deliverables
    - Phase 1: Sub-set 2: Additional Police Data and collision analysis

    - Phase 2: Sub-set 1: Enhanced Deliverables (is to be a separately managed and completed Project, not part of this scope)
- Resourcing Strategy:
    - A contractor was brought in to implement the project and act as the MSA
    - All other resources were expected to be City employees or associated Contractors for the specific groups
    - Calgary Police Service personnel are required to provide the necessary programming to supply:
        - additional data,
        - the supporting information for the additional data, and
        - a refresh of data for one-time data load (between initial load and new data inclusion
    - The Vendor would remain responsibility for application customization and data population with support from the City personnel
- A Two-phased approach to delivery:
    - Initial expectation was to break Phase 1 into two sub-sets. Due to architecture discussions and associated timing, the two phases were joined together into one delivery at the end of the cycle (August / September timeframe)
    - The second Phase remains as out of scope and to be completed as a separate but related project

Key Deliverables

Key (significant) products the project will produce (9). The items listed here are related only to the current Phase, which makes up the scope of this project. Figure 1 outlines the project phasing.

- Server infrastructure to support Vendor / business requirements
- Working production system / database
- Training Material (Vendor)
- Trained users (Vendor)
- Converted data
    - Historical data converted
    - Weekly Police feed incorporated into application (manual process)
- Tested user procedures
- ITS supporting documentation
    - Project Framework
    - Project work-plan
    - System Architecture
    - System Test plan
    - Implementation Plan

- Phase 1 - Implementation of Ontrac2 software with Base Deliverables (as written in the contract, Schedule A, December 23, 2002):
    - Import and parsing of collision data provided by Calgary Police Service. (Note: If standard data elements were expected to be collected in the future (e.g., age and sex information) the elements were to be defined at this time.)
    - Validation of collision records based on user-configurable data validation rules and hard-coded rules specific to The City of Calgary.
    - Management of the collision data import and validation process.

- Searchable collision records based on data contained in the collision record and / or data contained in the map reference tables.
- Display of summary collision records data based on search criteria.
- Access of collision details for a specific collision by selecting that collision from a listing of records generated by a specific search.
- Changing of collision details for a specific collision by selecting that collision from a listing of records generated by a specific search.
- Viewing the location of a specific collision by selecting that collision from a summary of records generated by a specific search.
- Change location-related details for a specific collision by selecting that collision from a summary of records generated by a specific search and then using the map display screen.
- Assignment of location-related details for a specific collision that has not been spatially referenced by selecting that collision from a listing of records generated by a specific search and then using the map display screen.
- Creation of a text-based summary report for a specific collision (codes are replaced by text descriptions).
- Viewing locations of all collisions contained in the summary of records generated by a specific search (using the map display screen).
- Creation of standard reports describing all collision records generated by a specific search.
- Selection of specific frequency or rate reports and summarize, by location, all records generated by a specific search.
- Exportation of standard summary reports to Microsoft Excel for further analysis.
- Selection of collisions based on map-based identification of intersections and mid-block locations.
- Display of collision details by selecting a collision referenced on the map display screen.
- Importation of existing base mapping data based on a prescribed standard format (includes base road network, cosmetic objects, intersections, monument, and address data).
- Reporting on map and data inconsistencies.
- Single user types and privileges.

Implementation & Phasing:

The implementation and phasing of the project introduced a number of additional variables. These included a re-formulation of the RoadNet, previously referred to as a potentially affected system. Additionally, in subsequent phasing the incorporation of traffic volumes into the application introduced levels of complexity originally unforeseen (10). A consulting firm (GeoDynamics) was engaged to create a version of RoadNet, referred to as CrashNet that differed from the corporate standard single line street-file. CrashNet, essentially was a GIS version of RoadNet that maintained topological relationships, segment continuity, and intersection (node) breaks at the appropriate locations.

CRASHNET – Network Establishment

During the initial stages of creation of CRASHES, it was deemed that the old version of RoadNet would not suffice. The old version of RoadNet was a CAD based system in which there was an individual segment in the road network for every single break in the road. For example, a simple segment of road from one intersection to another intersection would consist of at least three individual segments.

- Segment 1: intersection to alley
- Segment 2: alley to alley
- Segment 3: alley to intersection

Often the direction of each of these segments would be different as well thus creating errors in geocoding as well as directions of traffic flows. It was now sought out that a new, GIS (Geographic Information System) based RoadNet would be created to simplify the road network and be used as the base layer in CRASHES (11).

Business Rules (Segments)

There are 7 main business rules that are to be incorporated during the construction of CRASHES. Please note that these business rules are for the City of Calgary. Many of these rules are easily customizable and can be used at the discretion of the jurisdiction administering the project.

- Street segments included:
  - Expressway
  - Major
  - Collector
  - Street
- Street segments exclude:
  - Alley
  - Walkway
  - Pathway
  - Private roads
  - Ramps
- Hierarchy of Streets:
  - Expressway
  - Major
  - Collector
  - Street
  - Segment Direction
- Direction for bi-directional segments will go from North-South, then West to East
- Direction for one-way segments will be in the flow of traffic

Street Naming

- The naming convention for NAME_EXT is:
  - Current Street name **between** from street name **and** to street name, where:
    - The current-Street name is the street name of the segment.
    - From-street-name is the name of the intersecting street with the highest hierarchy at the start point.
    - To-street-name is the name of the intersecting street with the highest hierarchy at the end point.

- The naming convention for NAME is:
    - Current Street name **btwn** from-street-name ***/*** to street name, where:
        - The definitions are as above
        - Replace "BETWEEN" with "BTWN"
        - Replace "AND" with "/"
        - Ensure Street Type is 2 characters (should always be this way)
        - Keep Quadrant identifier on Current Street and drop on other two streets (i.e., From and To)
        - Keep space between Street Type and Quadrant

- Exclude all rural RoadNet segments and use City segments only.

- Segment Reconstruction:
    - This is where segments of the same street name are merged into one segment. (Since alleys are removed, there will be one segment between 2 intersections)
    - In some cases during re-construction, the directions may need to be flipped in order to meet business rule 3.
    - If a street intersects with itself, it will have to be treated as an intersection.

- The excluded street segments that were removed at the beginning of the creation of RoadNet can be placed in at the end for aesthetic and reference purposes.

Business Rules (Intersections)

The CRASHES intersection is a separate layer from the segments layer, but is created in conjunction with the segments layer with built in functionality with ArcGIS. Intersection points shall be placed at the centre of the intersection or as close as possible for the large interchanges.

The naming conventions follow the same rules as above for segments as each intersection will have a unique name. In the case where we have multiple intersections with the same name, a direction indicator is used such as N, S, E or W.

Maintenance

As the city grows and expands, it is crucial to maintain the CRASHES segments and intersections files in a consistent manor. To maintain and add segments and intersections in each layer in CRASHES, powerful, built in editing functionality with in ArcGIS allows the maintainer to add new segments, add new intersections, merge segments and fix ones that have changed. Following the above business rules is essential to maintain a consistent road network. Editing occurs regularly with data uploads occurring on an as-needed or quarterly basis.

TRAFFIC VOLUMES Integration

Part of the CRASHES functionality involves the incorporation of traffic volumes into the system (12). Currently, volumes at road intersections only are required to produce collision rate reports. At this point in time, traffic counts mid-block, at driveways, private streets, alley ways etc. are not being incorporated into CRASHES. As the system matures, these special counts can be integrated into CRASHES to enhance the usability. Also, as technology and research evolves, collision prediction modeling can be included as part of the CRASHES functionality as the data requirement of the formula, volumes, is already within the system.

Existing Traffic Volume Application (Traffic Count)

The City of Calgary's Transportation Data Division currently uses an application called Traffic Count to maintain and store all of it traffic volume data. Essentially, the volume is stored in an oracle database. The volume is then attached spatially, to a bounding box which covers the whole intersection as well as any ramps or turning lanes associated with it. The boxes are based on an old version of RoadNet which is not being used in CRASHES. In some cases, the boxes may big and rectangular to include all turning ramps of the intersection Figure 3. The centroid of the bounding box may not even be at the centre of the intersection. The centre of the bounding boxes will be used as a way to integrate volumes into CRASHES.

CRASHES Intersection Points

The CRASHES intersection points are based on the new CRASHES RoadNet. In the new RoadNet, segments of road are only broken down at intersections that involve another street. Alley ways, driveways etc. are not included in the new CrashNet but are included in the end for cosmetic purposes. At each of the intersecting streets, there is an intersecting point built within the network structure (Refer back to Network Establishment). A separate layer within CRASHES is created with only intersection points. Points are placed on top of the intersections in RoadNet. Cases that require special attention when creating an intersection point are interchanges and dog leg intersections. For interchanges, the point will be placed at the centre of the intersecting roads, for dog leg intersections, the point will be placed in the middle of the two offset roads. In cases where the dog leg streets are far apart, the intersection will be treated as two separate intersections each requiring their own points.

Use of GIS (Geographic Information Systems)

When dealing with spatial data in transportation, a GIS application such as ESRI's ArcGIS is becoming an important tool in data storage, data visualization and more importantly data manipulation and analysis. The role of GIS in this part of the project will be to spatially join the CRASHES intersection points to the centroids of the bounding boxes from Traffic Count. This will be done by a function in ArcGIS called the spatial join. This is where the attributes of the two data files can be joined together based on the locations of the points (ArcGIS Help menu). Once the attributes are joined, we can see which bounding box centroid corresponds to which CRASHES intersection.

Pre-Integration Issues

There are a few issues that arose prior to the actual integration of data.

- The id numbers between CRASHES intersection points and the Traffic Count bounding box id numbers are different. For example, for 16 Avenue NE and Deerfoot Tr NE, the CRASHES intersection has a different ID number than the Traffic Count Bounding Box number. ID matching has to take place in order to correlate the volumes to CRASHES.

- There are some intersections where there was not a CRASHES intersection point but there was volume data for the intersection. The volume data for these intersections can not be uploaded because there is no where for them to be attached to unless they are attached to an incorrect point.
- For interchanges, because the bounding boxes can be elongated with the centroid being displaced from the actual centre of the interchange (Figure 1), manual intervention must be done to correspond the right bounding box centroid to the correct CRASHES intersection point. The same manual intervention must be done where there is no CRASHES intersection point, but a traffic count has been done. In this case, the centroid point could be joined to another, incorrect intersection point which could be hundreds of meters away.

Integration

Two GIS shapefiles with all the volumes bounding box centroids and the CRASHES intersection points were created. For the volumes, any bounding box that was associated with an alley, ramp, driveways etc. was not included. A spatial join was made with the two sets of points. One of the attributes that is created with a spatial join is a distance between the two points joined. This indicates how close the volume point was to the CRASHES point. A threshold of 25m was used to determine whether manual intervention was needed. The assumption that was made was that any join under 25m was deemed to be good in that the correct intersection points we joined. For example, the CRASHES intersection point for 16 Av NE and 29 St NW had the corresponding volume data for that intersection. To be sure, a spot check of approximately 200 intersections was undertaken to ensure data quality.

There were a total of 4206 joins with approximately 500 needing to be manually checked (distance greater than 25m). At the end of the manual check, 4030 were correct (includes distance under 25m), 98 traffic volume points did not have CRASHES points at the location and 37 points were joined incorrectly which need to be fixed.

Once the traffic volume points were matched with the corresponding CRASHES points, the traffic volume id numbers were sent back to acquire the traffic volume data. Upon return of the data, 2659 pairs were returned with data. This was due to locations having old traffic data or locations that did not meet certain criteria of being included in the CRASHES system.

Although this task seems heavy handed, it only has to be done once as each year, only the new points will need to be added to the system.

Maintenance

Because the city grows and changes constantly, there has to be a process in place to regularly maintain the system. Every year, approximately 200 counts are conducted which include intersection counts, mid block counts, driveway counts etc. The majority of these are counted between April and September. At the end of each year, all relevant, new traffic count points should be selected out of the system and put through the integration process. This would include new intersections being counted as well and new counts at existing intersections. New CRASHES points will be added to the system where before a traffic count was conducted but not associated CRASHES point.

CRASHES – Support

Once the system was established and implemented, a secondary consideration was on-going support. As noted earlier, each of the affected ancillary programs requires their own level of support; i.e. the CrashNet needs to be constantly updated, as does the traffic volume input. Figure 4 identifies the inter-relationships between the various stakeholders and identifies how the CRASHES (OnTrac) system is sustained from a corporate perspective (13).

SUMMARY

Once all the volume data is integrated and the system matures, new functionality can be included into the system. One such data reporting tools is collision prediction modeling. This function allows the user to determine if collisions are over represented or under represented at an intersection. This allows planners, specialists and engineers to determine locations where work may need to be done to enhance safety of the road user. In literature that deals with collision prediction modeling, the primary data input is volumes at the intersection. CRASHES now has volume data in the system and once the system is established, the functionality can be built in as another piece of data in the user arsenal. Ultimately, the longer term vision is to fully integrate the data management functionality with the other stakeholders, as noted in Figure 5.

Figure 1 – CRASHES Project Plan

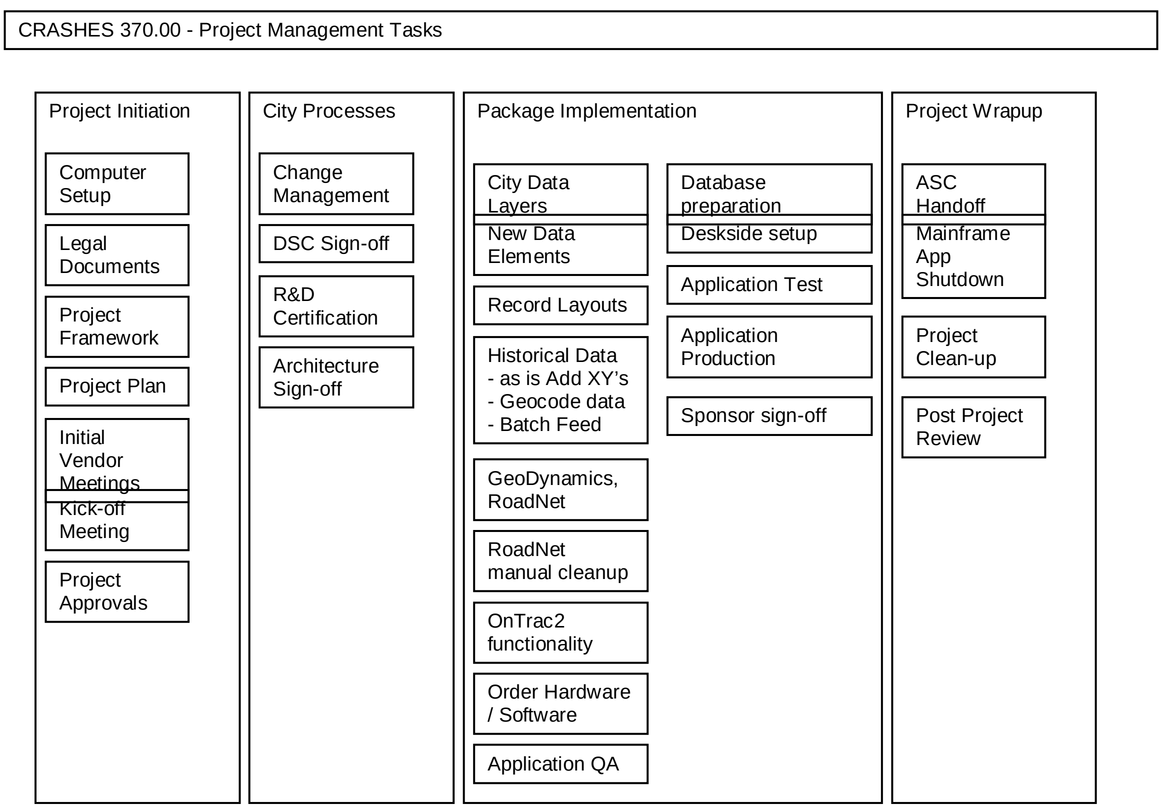


Figure 2 CARS Implementation Phasing

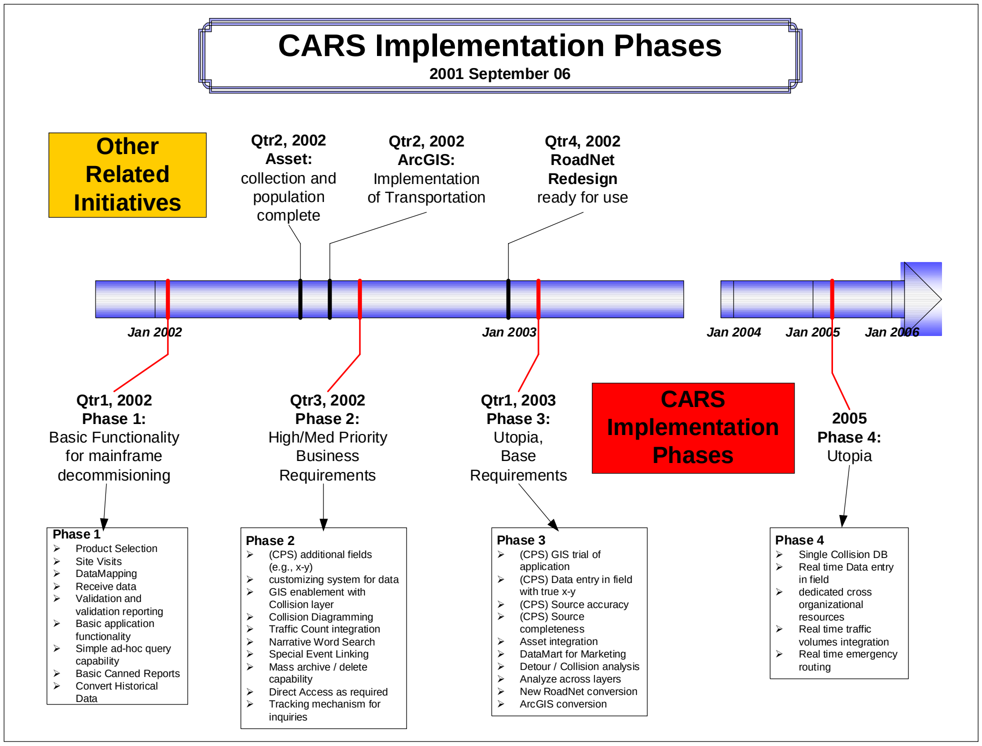


Figure 3 – CrashNet Traffic Volume Integration (Bounding Boxes)

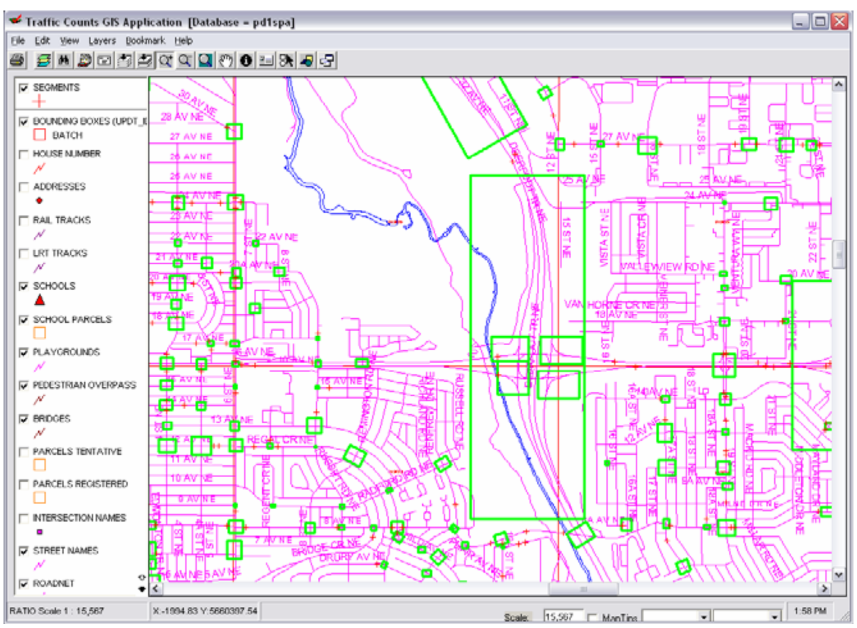


Figure 4 – CRASHES Support Model

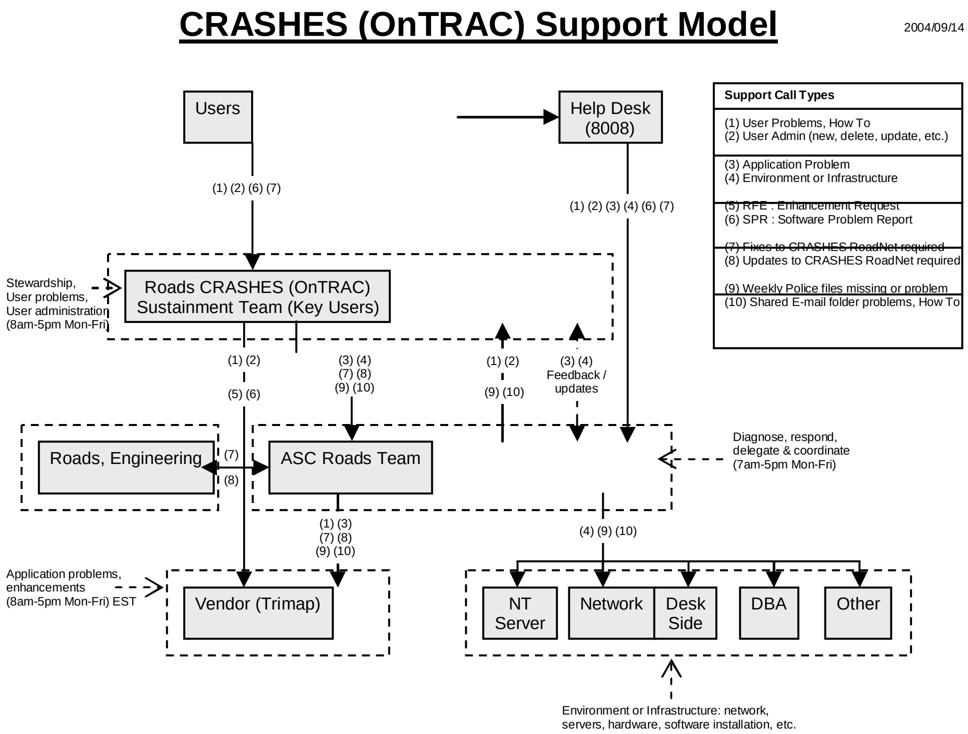
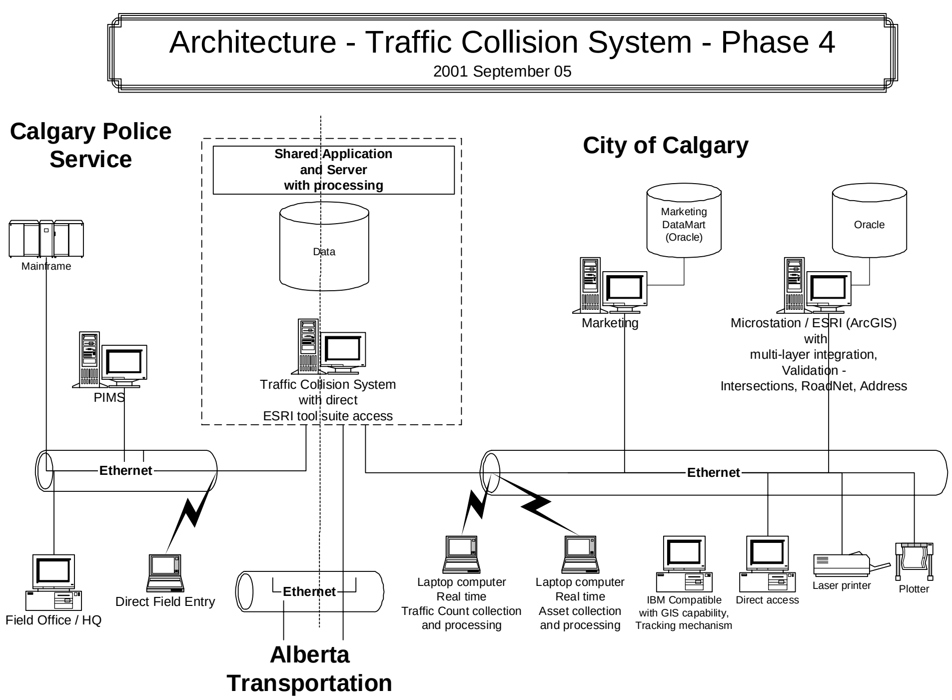


Figure 5 – Integrated Collision Systems Phase IV Architecture



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